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In re Patent Application of: Brian L. Schmidt et al.
Title: CONFIGURATIONS AND METHODS FOR MAKING CAPACITOR CONNECTIONS
Attorney Docket No.: 279.268US1

PATENT APPLICATION TRANSMITTAL

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X Specification (18 pgs, including claims numbered 1 through 48 and a 1 page Abstract).
X Drawing(s) (7 sheets).
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[ ] MULTIPLE DEPENDENT CLAIMS PRESENTED				$0.00
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UNITED STATES PATENT APPLICATION

CONFIGURATIONS AND METHODS FOR MAKING CAPACITOR CONNECTIONS

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CONFIGURATIONS AND METHODS FOR MAKING CAPACITOR CONNECTIONS

Cross-Reference to Related Applications

This application is related to Application Serial Number xx/yyyyyy (Attorney Docket # 279.234US1), filed on even date herewith, entitled FLAT CAPACITOR FOR AN IMPLANTABLE MEDICAL DEVICE, which is incorporated herein by reference in its entirety.

Technical Field

The present invention concerns implantable medical devices, such as defibrillators and cardioverters, particularly structures and methods for capacitors in such devices.

Background

Since the early 1980s, thousands of patients prone to irregular and sometimes life-threatening heart rhythms have had miniature heart monitors, particularly defibrillators and cardioverters, implanted in their bodies. These devices detect onset of abnormal heart rhythms and automatically apply corrective electrical therapy, specifically one or more bursts of electric current, to hearts. When the bursts of electric current are properly sized and timed, they restore normal heart function without human intervention, sparing patients considerable discomfort and often saving their lives.

The typical defibrillator or cardioverter includes a set of electrical leads, which extend from a sealed housing into the walls of a heart after implantation. Within the housing are a battery for supplying power, monitoring circuitry for detecting abnormal heart rhythms, and a capacitor for delivering bursts of electric current through the leads to the heart.

The capacitor may take the form of a flat aluminum electrolytic capacitor. This type of capacitor generally includes a stack of flat capacitive elements, with each capacitive element including a paper separator between two sheets of aluminum foil. The aluminum foil layers are divided into a group of anode layers and a group of cathode layers.

The anodes and the cathodes of the capacitor elements are connected together to provide a total capacitance. After being connected, the respective anodes and cathodes are connected to terminals for being coupled to circuitry outside the capacitor case. These internal and external connections can be time-consuming to make and can take up valuable space both within and outside the capacitor.

Since defibrillators and cardioverters are typically implanted in the left region of the chest or in the abdomen, a smaller size device, which is still capable of delivering the required level of electrical energy, is desirable.

Accordingly, there is a need for capacitor structures and methods of manufacture which provide greater process control, less expensive manufacturing, provide for a design efficiently utilizing space within the capacitor case, and provide for a compact capacitor design capable of providing the required pulse of energy for use within the implantable device.

Summary

To address these needs, capacitor structures and assembly methods have been devised. One capacitor has a capacitor stack positioned in a case with a cathode conductor positioned between a cover and the case. In one embodiment, an anode conductor is positioned between the cover and the case. In one embodiment a cathode conductor is positioned between the cover and an upper rim of the case and is welded to the cover and case. One or more of these embodiments provide an arrangement which reduces the space required for connecting and routing the cathode conductor and thus allows a reduction in the size of the capacitor, or alternatively an increase in its energy storage capacity.

One aspect provides a capacitor having a capacitor terminal wire which is electrically connected to a capacitor case by welding or brazing an end of the wire to the case in an end-on fashion. In one embodiment, the end of the wire is expanded so as to be, for example, in the shape of a nailhead. The expanded end presents sufficient surface area to enable a mechanically stable connection while minimizing the size of the footprint of the case within the housing of an implantable medical device.

One aspect provides interconnections between anode and cathode layers which are made by round wire connectors that are attached to the individual anode and cathode layers. The anode layer wires are connected to one another as they exit the layers, and the cathode layers are likewise connected together. In some embodiments, the wire connectors are gathered into corresponding wire bundles as they exit the layers, and the bundles can then be twisted together into a cable that can be laid in any direction to be routed through a feedthrough hole to terminal connections.

Other facets of the invention include various implantable medical devices, such as pacemakers, defibrillators, and cardioverters, incorporating one or more novel capacitors, as well as various methods of manufacture.

Brief Description of Drawings

Figure 1 is an exploded perspective view of a capacitor according to one embodiment of the present invention.

Figure 2 is a cross sectional view of portions of the capacitive stack of Figure 1.

Figure 3 is a partial cross sectional view of a capacitor with a cathode conductor positioned between the cover and the case according to one embodiment.

Figure 4 is a partial cross sectional view of a capacitor with the cathode conductor attached to the cover and the case according to one embodiment.

Figure 5 is a partial cross sectional view of a capacitor with the cathode conductor welded to the cover and the case according to one embodiment.

Figure 6A is a view of a flat capacitor foil with an attached round wire connector according to one embodiment.

Figure 6B is a perspective view of a flat capacitor showing round wire connectors for interconnecting anode and cathode plates.

Figure 7 is a view of a capacitor with an expanded end of a terminal wire attached to a case according to one embodiment.

Figure 8A is a later view of a terminal wire attached to a case according to one embodiment.

Figure 8B is a later view of a terminal wire attached to a case according to one embodiment.

Figure 9 is a schematic view of one embodiment of an implantable heart monitor having an energy storage component incorporating one or more capacitors in accordance with the invention.

Detailed Description

The following detailed description, which references and incorporates the figures, describes and illustrates one or more specific embodiments of the invention. These embodiments, offered not to limit but only to exemplify and teach the invention, are shown and described in sufficient detail to enable those skilled in the art to practice the invention. Thus, where appropriate to avoid obscuring the invention, the description may omit certain information known to those of skill in the art.

Figure 1 shows a perspective view of a capacitor 18 according to one embodiment of the present invention. Capacitor 18 includes a capacitor container 20 including a case 22 and a lid, or cover 24 overlying case 22 for placement on an upper rim 26 of case 22. Although in one embodiment capacitor 18 has a D shape, other embodiments include square, oval, circular, rectangular and other symmetrical and asymmetrical shapes. A capacitor stack 28 with a top surface 30 is enclosed by container 20 which defines a chamber 32.

Capacitor stack 28 includes a plurality of cathode and anode foil layers separated by one or more separators. The anode foil layers are connected together and coupled to a feedthrough conductor 34. In one embodiment, feedthrough conductor 34 passes through a hole in case 22, and conductor 34 is electrically isolated from case 22.

The cathode foil layers of stack 28 are connected together and connected to a conductor 36. In one embodiment, cathode conductor 36 is a tab strip which is integral to one of the cathode layers. In other embodiments, cathode conductor 36 is a strip of aluminum tab stock connected to one or more of the cathode foil layers. Cathode conductor 36 provides an electrical connection between the cathode layers and case 22.

Figure 2 shows a capacitive element 38 in accord with one embodiment. Capacitor stack 28 includes a plurality of generally flat capacitive elements 38. Capacitive element 38 includes foil layers such as cathode layer 40 and anode layers 42 each of whose electrical elements are connected in parallel. In this embodiment, anode layers 42 form a triple anode structure. Other embodiments include single, double, triple, four, and/or more anode foils.

In one embodiment, the foil layers are etched and/or perforated. The number of capacitive elements determines the capacitance and thickness of the capacitor. Separators 44, such as two or more paper sheets, cover the opposite sides of the anode layer 42 as well as the opposite sides of cathode layer 40. At the periphery, the separators extend slightly beyond the cathode layer and the anode layers to prevent electrical shorting due to any misalignment.

Figures 3-5 show a partial cutaway view of capacitor 18 during respective manufacturing stages in accord with one or more embodiments of the present invention. Capacitor stack 28 includes top surface 30 and a lateral face 46 and includes one or more parallel connected capacitive elements, such as capacitive element 38 shown on Figure 2. In one embodiment, the anodes of each capacitive element have respective tabs (not shown) compressed together and welded at their

free ends, such as with a YAG laser. The welded tabs are then welded (or otherwise fastened or attached) to feedthrough conductor 34 that passes through case 22. (See Figure 1). In some embodiments, an unetched, integral portion of each of one or more anodes is used to weld or attach the anode layers to one another.

In one embodiment, cathode tabs are attached or fastened to cathode conductor 36. As noted above, in some embodiments cathode conductor 36 is an integral extension of a cathode foil layer, meaning for example, that the cathode conductor and cathode foil layer are formed from a single piece of foil.

In one embodiment, cathode conductor 36 extends from capacitor stack 28 and is positioned and pinched between upper rim 26 of case 22 and cover 24. Cover 24 and case 22 form an interface or seam 48 at upper rim 26. Cathode conductor 36 is positioned in interface 48 between case 22 and cover 24. Cathode conductor 36 is pinched between case 22 and cover 24 defining an inner conductor portion 50 and an outer conductor portion 52. As shown in Figure 4, in one embodiment, at least a portion of the outer conductor portion 52 is trimmed off of the cathode conductor 36.

In some embodiments, cathode conductor 36 is welded into place during the base/cover welding process, providing a mechanical and electrical connection to the case 22 without a separate connection procedure. In contrast, if the cathode conductor is connected to the case in a separate procedure, the extra connection requires that part of the capacitor stack be removed or the case be enlarged to allow space for routing and connecting the conductors, thereby reducing the packaging efficiency of the capacitor. The reduced packaging efficiency ultimately results in a larger capacitor. In some embodiments, conductor 36 is welded or otherwise fastened to the interior or exterior of cover 24 or to the exterior of case 22.

Figure 5 shows a partial cutaway view of exemplary capacitor 18 with cover 24 welded to case 22. Cathode conductor 36 is positioned between case 22 and cover 24 at upper rim 26. Cathode conductor 36 is welded in the interface 48 between cover 24 and case 22, providing a mechanical and electrical connection to

the container 20. The welded conductor 36, cover 24 and case 22 are welded together with a single bead 54. Optionally, the bead forms a hermetic seal between the cover 24 and case 22.

Among other advantages, one or more of the embodiments described above provide a capacitor structure which reduces the space required for connecting and routing the cathode conductor and thus allows a reduction in the size of the capacitor, or alternatively an increase in its energy storage capacity.

The embodiments described above show the cathode conductor electrically connected to the housing forming a cathodic housing. Alternative embodiments include positioning the anode conductor between the cover and case thereby connecting the anode layers and anode conductor to the housing forming an anodic housing.

An exemplary embodiment of a method to connect a cathode conductor to a capacitor housing is described below. The cathode conductor is connected to the housing by positioning the conductor between the case and the cover; positioning the cover on the case; and attaching the cover to the case so that the conductor is electrically and mechanically connected to the housing. In addition, other embodiments include positioning the conductor between the case and the cover at the upper rim and attaching the cover to the case at the upper rim. In one embodiment, the case and the cover form an interface and the positioning of the conductor between the case and the cover is in the interface. In another embodiment, the attaching the cover to the case comprises welding or soldering the cover to the case. The cathode conductor is welded into place using a single bead during the welding of the cover to the case, eliminating a separate step of connecting the cathode conductor to the case.

Fig. 6A shows a top view of a foil connection according to one embodiment of the present invention. In this embodiment, a wire connector 260 is attached to a major surface of an anode layer 110 along a portion of the wire connector's length.

In one embodiment, wire connectors are similarly connected to the cathode layers of the capacitor stack. In one embodiment, wire connector 250 is made of a high purity aluminum, and is a round wire and includes a diameter allowing the desired amount of bending and twisting as the connectors is routed through the capacitor case.

Figure 6B shows a capacitor in accordance with one embodiment in which one or more round wire connectors 250 are connected to the cathode layers 120 and wire connectors 260 are connected to anode layers 110. The wire connectors may be made of high purity aluminum and are staked (or otherwise attached such as by welding, brazing, etc.) to the individual cathode and anode layers.

Wire connector 250 and 260 connect like types of layers together and can be used to connect the layers to external terminals. In the figure, the wires connected to the anode layers exit the layers at one common location while the cathode layer wires exit together at a different location. The anode layer wires 260 and cathode layer wires 250 are then gathered into corresponding wire bundles 261 and 251, respectively. The bundles can then be twisted together into a cable that can be laid in any direction to be routed through feedthroughs 280 to terminal connections. In the figure, the anode layers 110 are electrically connected to positive terminal 160, and the cathode layers are electrically connected to negative terminal 150. By directly connecting the round wire connectors to the capacitor layers, there is no need for tabs that add to the space requirements of the capacitor case.

In one embodiment, wire connectors 250 and/or 260 are insulated with the insulation removed at the point of bundling in order to electrically connect like types of layers together. In another embodiment, the wires are uninsulated and routed through the case via an insulated feedthrough hole.

Advantageously, in one or more embodiments, the cathode and anode wires can be gathered into bundles and twisted into a cable that can be routed in any direction through a feedthrough of the capacitor case. This allows greater space efficiency and a smaller case for the capacitor.

Figure 7 shows capacitor 18 having a terminal connection 30 in accord with one embodiment of the present invention. In this embodiment, feedthrough conductor 34 is attached to the anode layers inside the case as described above. The cathode layers are connected to the case in this embodiment, and terminal connector 30 is attached to the case in an end-on fashion by welding or brazing the end of the wire to the capacitor case.

In one embodiment, terminal connector 30 includes a body having an end surface which is substantially perpendicular to the body. The end surface is positioned so that the end surface is flushly positioned against the surface of the case and is butt-welded to the case, wherein terminal connector is only attached to the case at its end surface and not along any portions of its body.

In one embodiment, an expanded end 40 at the end of the wire is provided. The expanded end 40 in this embodiment is in the shape of a nailhead with a flat surface for attaching to the case. The surface area of the expanded end is sufficient to provide a securely welded connection while minimally altering the footprint of the capacitor case. The overall volume of the device housing can thus be reduced.

In Figure 8A, terminal wire 30 with an expanded end 40 at its end is attached directly to a capacitor case 20 by, for example, arc percussive welding or laser welding.

In Figure 8B, expanded end 40 is attached with braze 16 to a piece of intermediate material 14 welded to the case 20. Both methods of attachment result in a low height profile that minimizes the amount of interconnect space required for connection of the capacitor to an external terminal.

In the capacitors described above, the case is electrically connected to the cathode layers to form a cathodic or negative case. In another embodiment of the invention, a terminal wire with an expanded end is attached to an anodic case which is formed by the case inner surface being electrically connected to the anode layers of the capacitor. Also, although the invention has been described above with reference to electrolytic capacitors, the invention may also be used in conjunction

with other devices such as batteries or other types of capacitors such as wet tantalum capacitors. The term capacitor, as used herein, should be interpreted to include those devices as well.

Figure 9 shows one of the many applications for capacitors incorporating one or more teachings of the present invention: an implantable medical device 90. As used herein, implantable medical device includes any implantable device for providing therapeutic stimulus to a heart muscle. Thus, for example, the term includes pacemakers, defibrillators, congestive heart failure devices, and cardioverters.

Device 90 includes a lead system 92, which after implantation electrically contact strategic portions of a patient's heart, a monitoring circuit 94 for monitoring heart activity through one or more of the leads of lead system 92, and a therapy circuit 96 which incorporates a capacitor 98 having one or more features of one or more embodiments of the capacitors described below.

In addition to implantable medical devices and other cardiac rhythm management devices, one or more teachings of the present invention can be incorporated into photographic flash equipment. Moreover, one or more features can be includes in cylindrical capacitors. Indeed, the teachings are pertinent to any application where high-energy, high-voltage, or space-efficient capacitors are desirable.

Although the invention has been described in conjunction with the foregoing specific embodiment, many alternatives, variations, and modifications will be apparent to those of ordinary skill in the art. Such alternatives, variations, and modifications are intended to fall within the scope of the following appended claims.

What is claimed is:

1. A capacitor comprising:

a case;

a lid;

a capacitive element positioned in the case; and

a conductor electrically coupled to at least a portion of the capacitive element, with at least a portion of the conductor positioned between the case and the lid.

2. The capacitor of claim 1 wherein the conductor is coupled to a cathode of the capacitive element.

3. The capacitor of claim 1 wherein the conductor comprises an integral extension of a conductive layer of the capacitive element.

4. The capacitor of claim 1 wherein the case has an upper rim and the conductor is positioned between the upper rim of the case and the lid.

5. The capacitor of claim 1 wherein the conductor is electrically and mechanically attached to the case.

6. The capacitor of claim 1 further comprising a terminal wire electrically connected to the case by attaching an end of the terminal wire to the case in end-on fashion.

7. The capacitor of claim 1 wherein the case is aluminum.

8. The capacitor of claim 1 wherein the conductor comprises a strip of aluminum tab stock.

9. The capacitor of claim 1 wherein the case and the lid form an interface, the conductor positioned in the interface.

10. The capacitor of claim 9 wherein the conductor extends from the capacitive element to the interface.

11. A capacitor comprising:

a container having a case and a cover, the case and cover forming an interface;

a capacitive element positioned in the container;

a conductor electrically coupled to at least a portion of the capacitive element, with at least a portion of the conductor positioned between the case and the cover in the interface; and

wherein the conductor is electrically and mechanically attached to the case and the case and the cover are attached to each other.

12. The capacitor of claim 11 wherein the case, the cover, and the conductor are welded to each other.

13. The capacitor of claim 11 wherein the case, the cover, and the conductor are welded to each other during an uninterrupted welding process.

14. The capacitor of claim 11 further comprising a capacitive stack including the capacitive element positioned in the case.

15. The capacitor of claim 11 further comprising a terminal wire connected to the case in an end-on fashion.

16. A method of assembling a capacitor comprising:

providing a conductor connected to a capacitor stack; and

positioning the conductor between a first portion and a second portion of a capacitor case;

forming a mechanical and electrical connection between the conductor and the case.

17. The method of claim 16 further comprising trimming off a portion of the conductor extending outside of the case.

18. The method of claim 16 wherein forming a mechanical and electrical connection further comprises welding the conductor, the first portion, and the second portion to each other.

19. The method of claim 18 wherein welding the conductor, the first portion, and the second portion comprises using an uninterrupted welding process.

20. A capacitor comprising:

a stack of flat capacitive elements with each element including a flat anode layer and a flat cathode layer with a separator interposed therebetween; and

a round wire connector attached to each anode layer and each cathode layer, wherein the wire connectors electrically connect the anode layers in common and the cathode layers in common.

21. The capacitor of claim 20 wherein the anode layer wire connectors exit the layers at one location and the cathode layer wire connectors exit the layers at another location.

22. The capacitor of claim 21 wherein the anode layer and cathode layer wire connectors are each gathered into separate bundles.

23. The capacitor of claim 22 wherein the cathode layer and the anode layer bundles are connected to a first and a second capacitor terminals, respectively.

24. The capacitor of claim 23, wherein one of the first or the second capacitor terminals comprises a terminal wire which is electrically connected to the case by attaching an end of the terminal wire to the case in an end-on fashion.

25. The capacitor of claim 20 wherein the wire connectors are insulated.

26. A method for constructing a capacitor comprising:

stacking a plurality of flat capacitive elements with each element including a flat anode layer and a flat cathode layer with a separator interposed therebetween; and,

interconnecting the anode layers and interconnecting the cathode layers with a plurality of round wire connectors.

27. The method of claim 26 further comprising arranging the wire connectors such that the anode layer wire connectors exit the layers at one location and the cathode layer wire connectors exit the layers at another location.

28. The method of claim 27 further comprising gathering the anode layer and cathode layer wire connectors into separate bundles.

29. The method of claim 28 further comprising twisting the bundles into cables.

30. The method of claim 28 further comprising connecting the cathode layer and anode layer bundles to negative and positive capacitor terminals, respectively.

31. A capacitor comprising:

a case;

a capacitor stack; and

a terminal wire;

wherein, the capacitor stack is electrically and mechanically coupled to the case and wherein a terminal wire is attached to the case by attaching an end surface of the terminal wire to the case.

32. The capacitor of claim 31 wherein the terminal wire has an expanded end for attaching to the case.

33. The capacitor of claim 31 wherein the end of the wire is welded to the capacitor case.

34. The capacitor of claim 31 wherein the end of the wire is attached by brazing to a piece of intermediate material welded to the capacitor case.

35. The capacitor of claim 32 wherein the expanded end of the terminal wire is in the shape of a nailhead.

36. The capacitor of claim 31 wherein the terminal wire is connected to a cathodic case.

37. The capacitor of claim 31 wherein the terminal wire is connected to an anodic case.

38. A method for electrically connecting a terminal wire to a capacitor case comprising:

positioning an end surface of the terminal wire flushly against a surface of the case; and

attaching only the end surface of the wire to the case.

39. The method of claim 38 wherein the end of the wire attached to the case is expanded.

40. The method of claim 38 further comprising welding the end of the terminal wire to the capacitor case.

41. The method of claim 38 further comprising brazing the end of the terminal wire to a piece of intermediate material welded to the capacitor case.

42. An implantable medical device comprising:

one or more leads for sensing electrical signals of a patient or for applying electrical energy to the patient;

a monitoring circuit for monitoring heart activity of the patient through one or more of the leads; and

a therapy circuit for delivering electrical energy through one or more of the leads to a heart of the patient, wherein the therapy circuit includes one or more capacitors; and

wherein each capacitor comprises a container having a case and a lid, a capacitor stack positioned in the case, and a conductor electrically coupled to at least a portion of the capacitor stack and positioned between the case and the lid.

43. The implantable medical device of claim 42 wherein the first conductor is electrically and mechanically attached to the case.

44. The implantable medical device of claim 43, wherein the case, the cover, and the conductor are welded to each other using a continuous welding process.

45. An implantable medical device comprising:

one or more leads for sensing electrical signals of a patient or for applying electrical energy to the patient;

a monitoring circuit for monitoring heart activity of the patient through one or more of the leads; and

a therapy circuit for delivering electrical energy through one or more of the leads to a heart of the patient, wherein the therapy circuit includes one or more capacitors, each capacitor comprising a stack of capacitive elements with each element including an anode layer, a cathode layer, a separator interposed therebetween, and a round wire connector attached to each layer, wherein the wire connectors electrically connect the anode layers in common and the cathode layers in common.

46. The capacitor of claim 45 wherein the anode layer wire connectors exit the layers at one location and the cathode layer wire connectors exit the layers at another location.

47. The capacitor of claim 46 wherein the anode layer and cathode layer wire connectors are each gathered into separate bundles.

48. The capacitor of claim 47 wherein cathode layer and anode layer bundles are connected to a negative and a positive capacitor terminals, respectively.

CONFIGURATIONS AND METHODS FOR MAKING CAPACITOR CONNECTIONS

Abstract of the Disclosure

An exemplary capacitor has a capacitor stack positioned in a case with a conductor positioned between the case and a lid. In one embodiment the conductor is positioned between the lid and an upper rim of the case and is welded to the lid and case. In one aspect, a capacitor constructed with round wire connectors for interconnecting anode and cathode layers. In one aspect, a configuration for electrically connecting a terminal wire to a capacitor case in which an end of the wire is attached to the case in end-on fashion. The terminal wire may have an expanded end for attaching to the capacitor case in a manner that minimizes the effect on the height profile of the case.

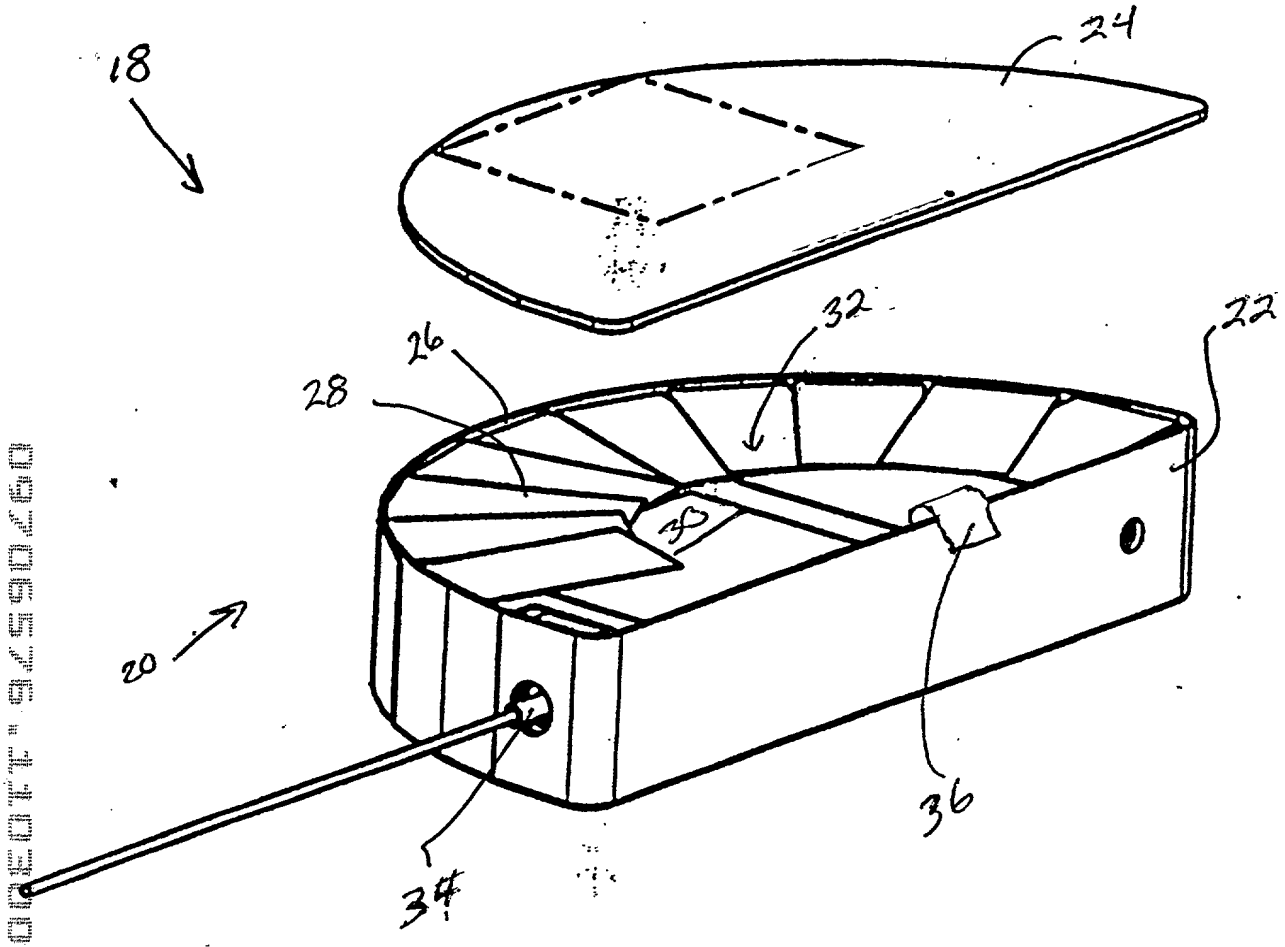

FIG. 1

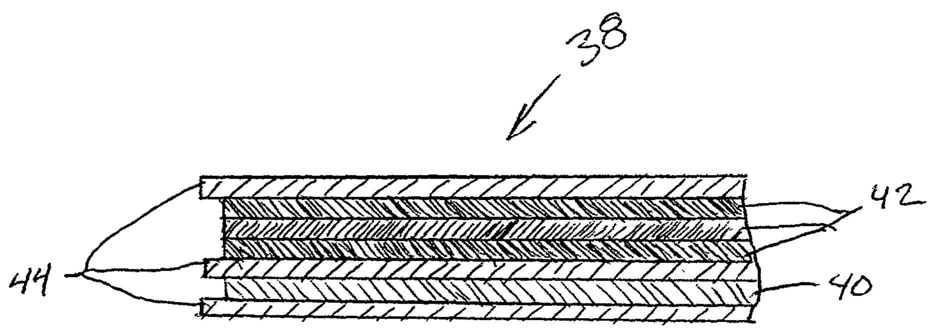

FIG. 2

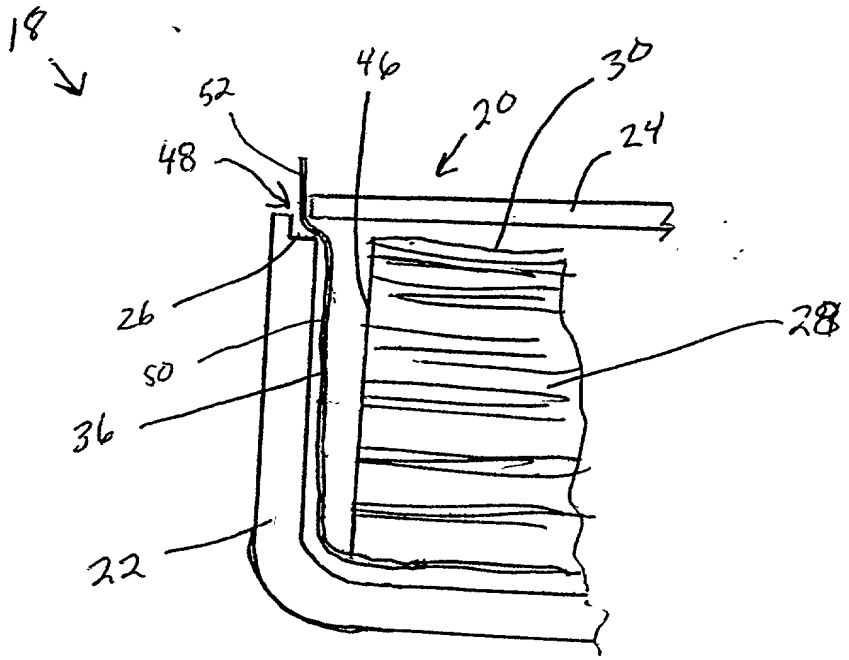

FIG. 3

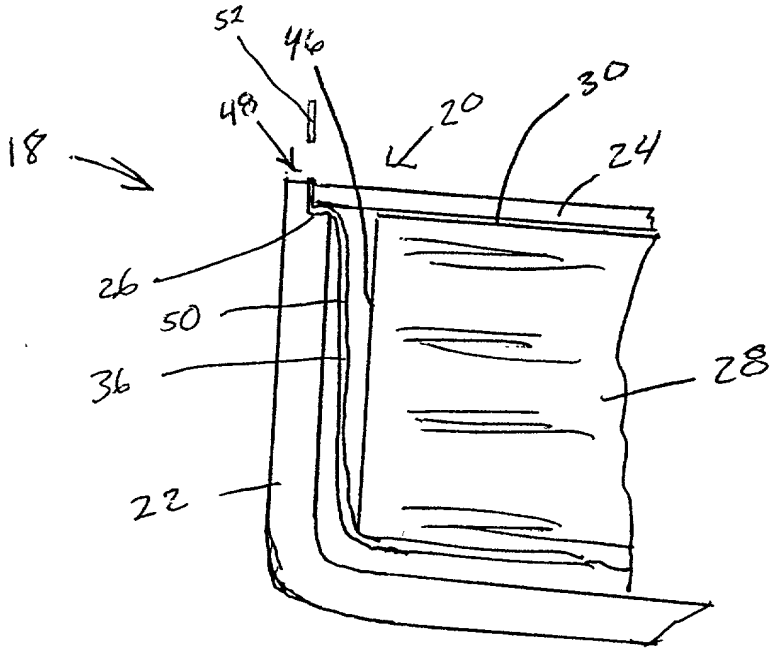

FIG. 4

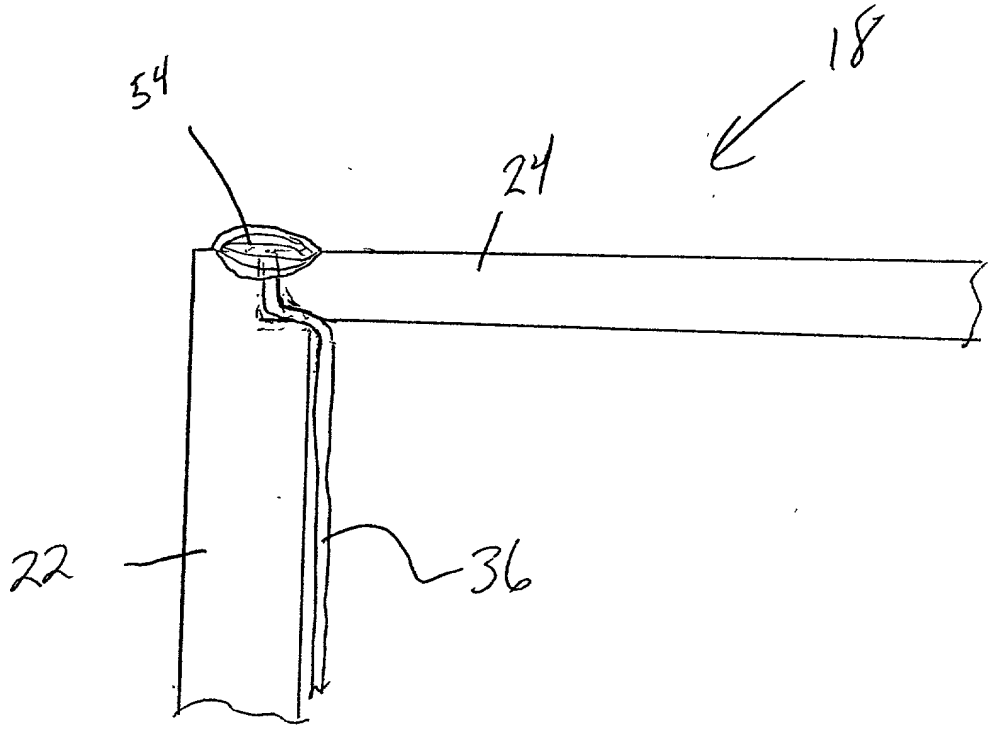

FIG. 5

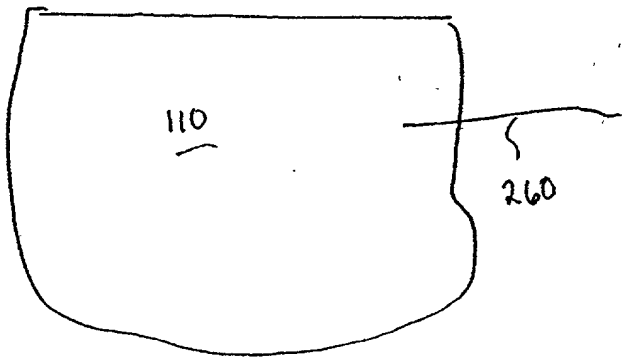

Fig. 6A

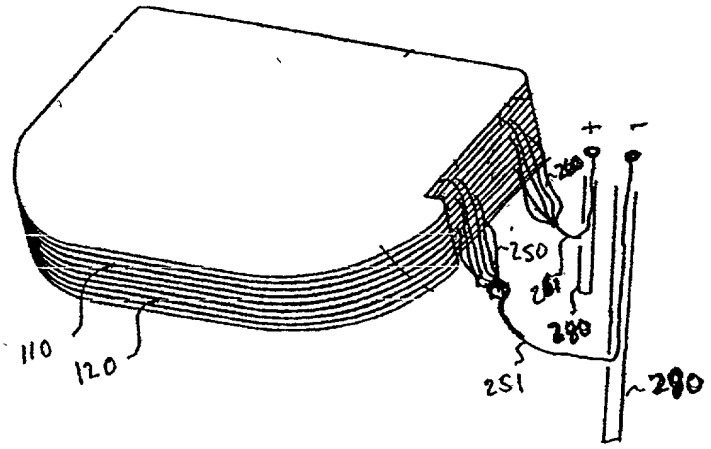

Fig. 6B

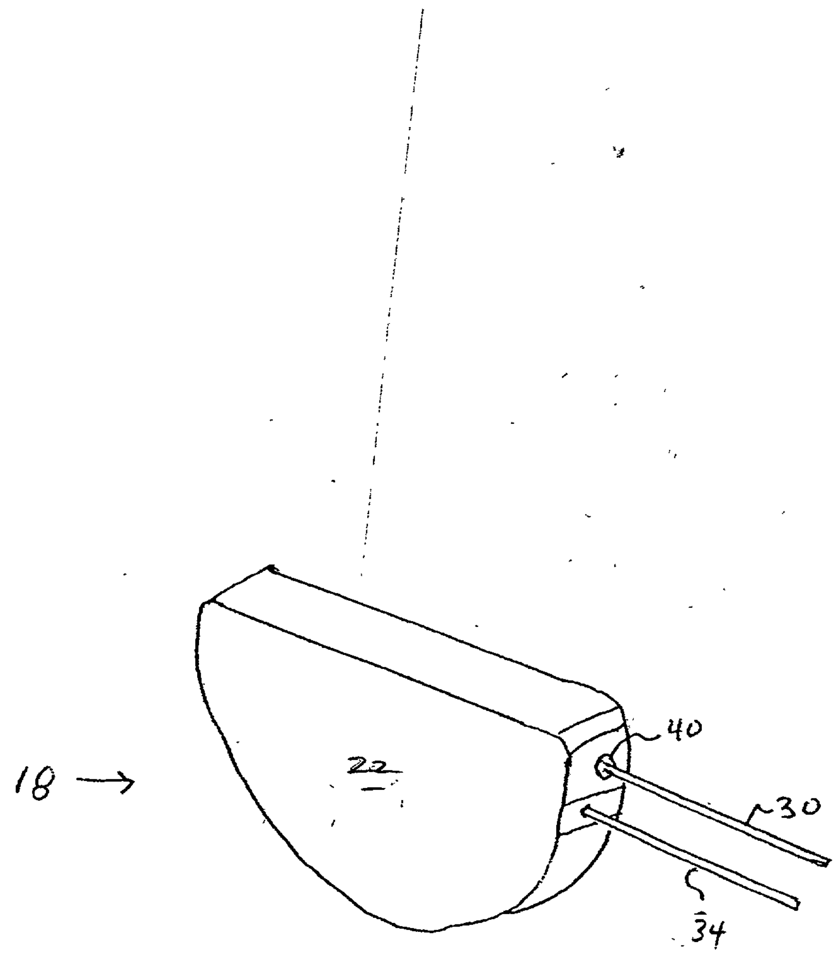

Fig 7

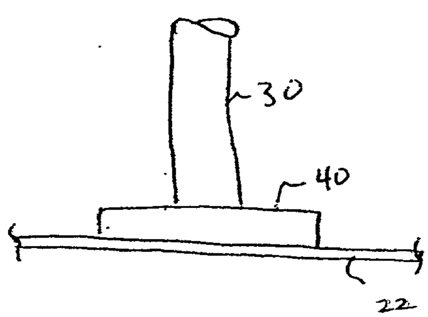

Fig. 8A

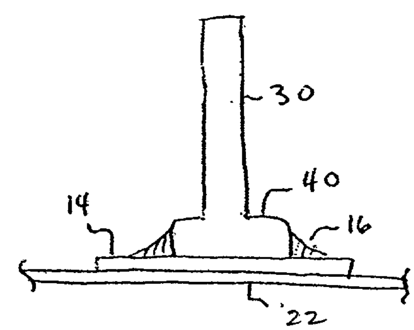

Fig. 8B

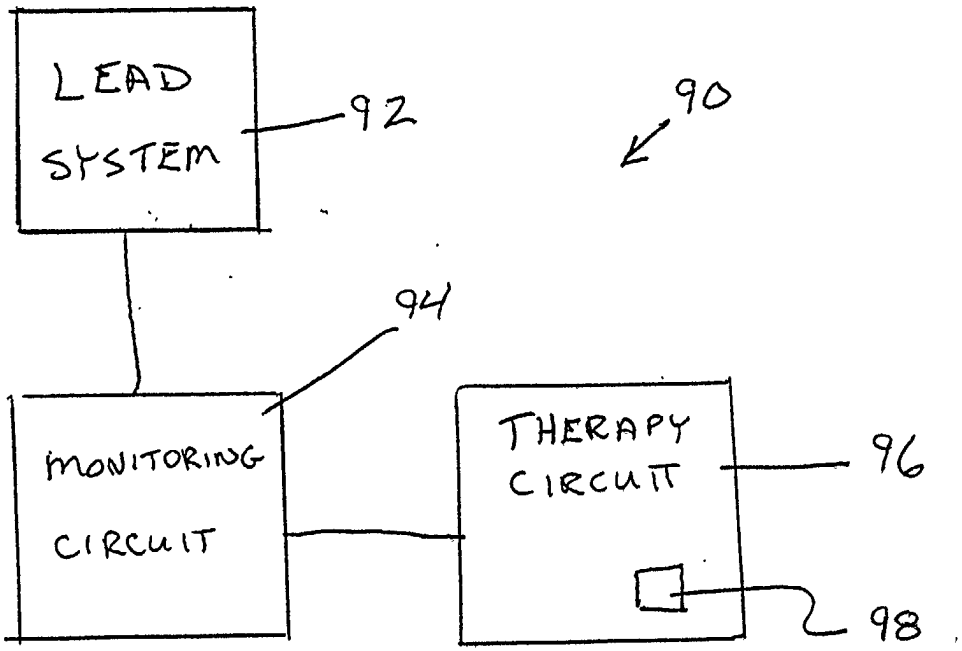
LEAD SYSTEM
92
90
94
MONITORING CIRCUIT
THERAPY CIRCUIT
96
98

FIG. 9

SCHWEGMAN ■ LUNDBERG ■ WOESSNER ■ KLUTH

United States Patent Application

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: **CONFIGURATIONS AND METHODS FOR MAKING CAPACITOR CONNECTIONS**.

The specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with 37 C.F.R. § 1.56 (attached hereto). I also acknowledge my duty to disclose all information known to be material to patentability which became available between a filing date of a prior application and the national or PCT international filing date in the event this is a Continuation-In-Part application in accordance with 37 C.F.R. §1.63(e).

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on the basis of which priority is claimed:

No such claim for priority is being made at this time.

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

No such claim for priority is being made at this time.

I hereby claim the benefit under 35 U.S.C. § 120 or 365(c) of any United States and PCT international application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. § 1.56(a) which became available between the filing date of the prior application and the national or PCT international filing date of this application:

No such claim for priority is being made at this time.

I hereby appoint the following attorney(s) and/or patent agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith:

Anglin, J. Michael	Reg. No. 24,916	Hill, Stanley K.	Reg. No. 37,548	Nasiedlak, Tyler L.	Reg. No. 40,099
Beekman, Marvin L.	Reg. No. 38,377	Huebsch, Joseph C.	Reg. No. 42,673	Nelson, Albin J.	Reg. No. 28,650
Bianchi, Timothy E.	Reg. No. 39,610	Jurkovich, Patti J.	Reg. No. 44,813	Nielsen, Walter W.	Reg. No. 25,539
Billion, Richard E	Reg. No. 32,836	Kalis, Janal M.	Reg. No. 37,650	Oh, Allen J.	Reg. No. 42,047
Black, David W.	Reg. No. 42,331	Kaufmann, John D.	Reg. No. 24,017	Padys, Danny J.	Reg. No. 35,635
Brennan, Leoniede M.	Reg. No. 35,832	Klima-Silberg, Catherine I.	Reg. No. 40,052	Parker, J. Kevin	Reg. No. 33,024
Brennan, Thomas F.	Reg. No. 35,075	Kluth, Daniel J.	Reg. No. 32,146	Perdok, Monique M.	Reg. No. 42,989
Brooks, Edward J., III	Reg. No. 40,925	Lacy, Rodney L.	Reg. No. 41,136	Prout, William F.	Reg. No 33,995
Chu, Dinh C.P.	Reg. No. 41,676	Lemaire, Charles A.	Reg. No. 36,198	Schumm, Sherry W.	Reg. No. 39,422
Clapp, Richard R.	Reg. No. 31,751	LeMoine, Dana B.	Reg. No. 40,062	Schwegman, Micheal L.	Reg. No. 25,816
Clark, Barbara J.	Reg. No. 38,107	Lundberg, Steven W.	Reg. No. 30,568	Scott, John C.	Reg. No. 38,613
Clise, Timothy B.	Reg. No. 40,957	Maeyaert, Paul L.	Reg. No. 40,076	Smith, Michael G.	Reg. No. 45,368
Dahl, John M.	Reg. No. 44,639	Maki, Peter C.	Reg. No. 42,832	Speier, Gary J.	Reg. No. 45,458
Drake, Eduardo E.	Reg. No. 40,594	Malen, Peter L.	Reg. No. 44,894	Steffey, Charles E.	Reg. No. 25,179
Embretson, Janet E.	Reg. No. 39,665	Mates, Robert E.	Reg. No. 35,271	Terry, Kathleen R.	Reg. No. 31,884
Fordenbacher, Paul J.	Reg. No. 42,546	McCrackin, Ann M.	Reg. No. 42,858	Tong, Viet V.	Reg. No 45,416
Forrest, Bradley A.	Reg. No. 30,837	Moore, Charles L., Jr.	Reg. No. 33,742	Viksnins, Ann S.	Reg. No. 37,748
Gamon, Owen J.	Reg. No. 36,143	Nama, Kash	Reg. No. 44,255	Woessner, Warren D.	Reg. No. 30,440
Harris, Robert J.	Reg. No. 37,346				

I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/organization/who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct Schwegman, Lundberg, Woessner & Kluth, P.A. to the contrary.

Please direct all correspondence in this case to **Schwegman, Lundberg, Woessner & Kluth, P.A.** at the address indicated below:

P.O. Box 2938, Minneapolis, MN 55402
Telephone No. (612)373-6900

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of joint inventor number 1 : **Brian L. Schmidt**
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Signature: _____ Date: _____
Brian L. Schmidt

Full Name of joint inventor number 2 : **Michael J. O'Phelan**
Citizenship: **United States of America** Residence: **Oakdale, MN**
Post Office Address: 6895 Upper 28th Street North
Oakdale, MN 55128

Signature: _____ Date: _____
Michael J. O'Phelan

X Additional inventors are being named on separately numbered sheets, attached hereto.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Post Office Address: 6830 Olympia Street
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James M. Poplett

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Folsom, CA 95630

Signature: _____ Date: _____
Robert R. Tong

Full Name of inventor:
Citizenship: Residence:
Post Office Address:

Signature: _____ Date: _____

Full Name of inventor:
Citizenship: Residence:
Post Office Address:

Signature: _____ Date: _____

§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.